GUIDELINES FOR RESEARCH PLANNING & DESIGN IN TASK ANALYSIS

William T. Farrell, C. Harold Stone, and Dale Yoder

Technical Report No. 4

EVALUATION OF THE MARINE CORPS
TASK ANALYSIS PROGRAM

A Research Project Supported By
Commandant of the Marine Corps (Code RD)
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Personnel and Training Research Programs
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This report focuses upon Task Analysis as research. It is based upon the the fact that the Task Analysis program conducted by the Office of Manpower Utilization, HQ, USMC (OMU) involves purposive, systematic investigations and analyses in order to prepare reports of findings that will be useful and influential in Marine Corps planning, policy determination, and management. Guidelines are presented for the planning and design of OMU's projects so that they will justify proper respect and credibility and thereby achieve maximum

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impact and value. Principles and procedures are outlined so that each Task Analysis project can be planned, designed and conducted in a manner consistent with recognized criteria of dependable scientific research. In addition to the focus upon the research nature of Task Analysis, the qualities of the researcher himself, and his influence upon the research are discussed. The main emphasis of the report is upon research planning and design. The main topics are: Statement of the research problem -- hypotheses; Contribution of theory; Operationalizing the research; Determining sample size; Collecting the data; Analyzing the data, with emphasis upon cluster analysis; and, The research report.

SUMMARY

This report focuses upon Task Analysis as research. It is based upon the fact that the Task Analysis program conducted by the Office of Manpower Utilization, HQ, USMC (OMU) involves purposive, systematic investigations and analyses in order to prepare reports of findings that will be useful and influential in Marine Corps planning, policy determination, and management. Guidelines are presented for the planning and design of OMU's projects so that they will justify proper respect and credibility and thereby achieve maximum impact and value. Principles and procedures are outlined so that each Task Analysis project can be planned, designed and conducted in a manner consistent with recognized criteria of dependable scientific research. In addition to the focus upon the research nature of Task Analysis, the qualities of the researcher himself, and his influence upon the research are discussed.

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TABLE OF CONTENTS

GUIDELINES
FOR
RESEARCH PLANNING AND DESIGN

I. TASK ANALYSIS AS RESEARCH

The Task Analysis program conducted by the Office of Manpower Utilization, HQ, USMC (OMU), was established to discover, develop, and report answers to questions that have significance in solving Marine Corps management problems. To this end, the Task Analysis program searches out and gathers relevant information, and analyzes these data to provide meaningful answers to specified questions about what Marines actually do in their various assignments. Thus it is clear that the mission of OMU is to conduct research, i.e., purposive, systematic investigation and analysis, and to generate reports of findings that will be useful and influential in Marine Corps planning, policy determination, and management. In all such research, the credibility and influence of reports and recommendations depend heavily on the evident logic, carefulness and thoroughness of research planning and design. It follows that if OMU's reports and contributions are to achieve maximum impact and value, the planning and design of projects must justify respect and high credibility. To accomplish this, each project must have been planned, designed and conducted in a manner consistent with widely recognized criteria of dependable scientific research. Such criteria have become generally recognized, accepted, and understood in every major scientific area.

Research in Occupational Task Analysis falls in the domain

of the behavioral sciences. This is so because it studies human behavior, and shares not only methods and techniques with Behavioral Science, but also because it implicitly and expressly strives for similar goals. While Task Analysis does not emphasize the goals of explanation and prediction, it parallels the logical processes of attaining such goals up through the interpretation of the meaning of data. Task Analysis strives to make valid empirical generalizations about the behavior of individuals who are engaging in activities in their natural environments.

As with any scientific endeavor, Task Analysis delimits the types of activities to be investigated and the context (environment) in which such activities are to be meaningfully observed. In the case of OMU, these activities are defined as tasks that relate to the performance of duties in the context in which they are legitimately performed. The purpose of this report is to suggest a framework for Task Analysis which formally recognizes its parallels and similarities with the methodology of the Behavioral Sciences and contributes to the production of high quality analysis and reporting. By making such a framework explicit, it is possible to standardize many of the steps in the process of OMU research. It additionally provides a system for internal evaluation of research findings and results.

Specifying phases and rationale. Well-designed research begins with a preliminary outline and definition of the specific

steps or phases to be undertaken, together with an explicit statement of the accompanying rationale for each step.

Analysis is not an activity unique to scientists. Every individual analyzes things many times a day. The difference between a scientist-analyst and a non-professional analyst is that the scientist specifically and consciously states the steps and rationale before and throughout his analysis. That is, there is an explicit method to his madness. It does not mean that his ultimate conclusions are necessarily any more correct than those of the layman (although they usually should be). What it does mean is that any other adequately trained professional can perform the same process and reach the same conclusion. If the same conclusion cannot be reached, then another scientist can check the logical steps and instruments used which led to the first conclusion and challenge them on the basis of scientific merit, rather than on personal and subjective feeling.

Part of the problem in non-scientific analysis is that many of the phases of the research are not made explicit. This has been an issue in the social and behavioral sciences for years. Only in the last generation has there been much systematic effort made to counter this trend. In Anthropology and Sociology particularly, the problem has become well-recognized. Beginning with some broad, general topic, researchers have often gone into previously unknown societies (or sub-groups in their own society) and have tried to absorb and

understand everything they see and hear. This naive and unstructured approach has sometimes been necessary in order to form the groundwork for a more problem-oriented analysis. Essentially, these analysts have been trying to learn to "think like an Indian" without knowing what such an activity really means. However, the recording of such observations has been of value. Basic data have now been collected so that contemporary researchers can gain much of the background information necessary for their studies through books, formal training, and informal conversations with individuals experienced in their fields of interest. Such reliance on existing resources not only saves valuable research time, but it also frequently results in superior research designs, data collection instruments, techniques, and analyses.

OMU can be said to be in a similar position. Beginning with a slight understanding of the problem, lack of experience in how to study the problem, and uncertainty as to how to interpret and analyze the results, OMU now has reached a point where it can benefit from the experience of past analysts and analyses. While there are undoubtedly some errors to be discovered in past studies, these studies none-the-less provide a background of analytic techniques and methodological orientations on which future research can be based. While it is not necessarily true that "experience is the best teacher," it is the unwise researcher who ignores it.

This report proposes to provide OMU with an Analytical Philosophy, or RESEARCH DESIGN that is general enough to be

used for any particular study. PART II discusses the qualifications of the researcher. PART III, the bulk of the report, describes the elements in research planning and design, noting especially the requirements for a definitive statement of the problem, the potential contributions of theory, and the process of operationalizing, including the literature search, observations and interviews, measuring instruments, and guidelines for sampling, data collection, analysis, and reporting. In overview, this report discusses a variety of technical questions such as PROBLEM DEFINITION, CONCEPTS AND OPERATIONAL DEFINITIONS, OPERATIONS, HYPOTHESES, AND EVIDENCE. It proposes a format for the systematic study of an Occupational Field. Additionally, and in some respects more importantly, it discusses the role of the researcher in the process of research.

II. THE RESEARCHER

The key factor in research is the researcher himself. No technique, method or reference material is so crucial and critical to the quality of the research as are the efforts and objectivity of the individual researcher. In general terms, what is a researcher? He is a product of a lifetime of experiences, attitudes, beliefs, biases, and opinions. He has technical knowledge in some field of activity, whether this be computer science, auto mechanics, physics, biology or carpentry or some other. He has spent his lifetime learning about the world around him and has formed opinions and theories regarding how

it functions and why. He has his own private philosophy, perhaps his own religion, and his own interests. Because of this, it is unrealistic to pretend that when he puts on his research hat he automatically becomes a completely objective observer of some phenomenon. His life experiences remain very real, and they guide his research efforts. And this is how it should be. In itself, this is neither good nor bad, but life experiences can be used poorly or well.

In order to use his personal qualities to his best advantages, the researcher must make explicit some of his personal feelings and beliefs so that he is consciously aware of what they are and how they may affect the way he goes about his task. This is especially critical in behavioral or social research where our feelings about the nature of man and our view of the world tend to be relatively unscientific and personal. It makes little difference in automotive design, for example, if the engineer is a Republican or a Democrat. However, if a political scientist is engaged in predicting election results, such a bias should be recognized in his research plan so that he would not make mistakes in constructing his questionnaire, selecting his sample, hiring and training interviewers and drawing conclusions from his data.

Further, a researcher has a certain amount of formal and informal knowledge about various things. At OMU, for example, several different technical specialties are represented among members of its staff. OMU analysts share a certain degree of knowledge with the people they study. This can be general

military knowledge, technical knowledge, or a combination of both. When one Marine meets another, and they discuss their jobs, a certain amount of knowledge is informally transmitted. As a consequence, it is rare to find a Marine who has no knowledge whatever of what someone does in Motor Transport, Tanks, or Intelligence. The point to be made here is that it is naive to assume that there is such a thing as a completely naive approach to Task Analysis. Rather than trying to mimic the ostrich and hide one's head in the sand, OMU needs to make critical use of the broad range of knowledge its analysts may have with respect to a particular Military Occupational Specialty (MOS) or Occupational Field (OF). Such knowledge can provide valuable insights both in instrument construction and analysis. The issue here refers back to what was mentioned regarding the exchange of knowledge by researchers in the behavioral sciences. If it were necessary to gain information about a society or an institution only by means of primary sources, research would not be additive, and there would be little productive problem-oriented research conducted by behavioral scientists today.

In summary, the researcher should be aware of personal attitudes and feelings that can color his perceptions and interpretations of data developed in each particular project or study. He should further understand that neither he nor any of his coworkers is completely naive. OMU administrators can benefit from similar understanding and can use the background of knowledge and insights represented in its cadre of researchers.

III. RESEARCH PLANNING AND DESIGN

Broadly, a Research Design is a set of interrelated plans which researchers develop and use in order to solve a problem. It is much the same as the plans for constructing a building or an airplane, or for getting to the moon. A Research Design specifies the aims and objectives of the research, the materials and the tools and information needed, the sequence or order in which the materials are assembled, and the standards against which the results are to be judged.

The elements of a good research design are broad enough to be applicable to almost any field of scientific inquiry. In outline form, they follow the general and sequential pattern below:

A. Statement of the Research Problem--Hypotheses. Before any true research activity can be undertaken, the problem which generates the research must be stated explicitly. It is not enough to say that we want to know about the manpower requirements of an occupational field. However, that is a good starting point for the specific formulation of a problem. We need to specify beyond that exactly WHAT we want to know about manpower in an Occupational Field (a problem) and WHY we want to know it (a rationale).

Often the central HYPOTHESIS is buried in the statement of the problem. For example, it may be that a fair general statement of the problem at OMU is:

> To what degree do the current structure of of OFxx and the training of Marines with a designated MOS in that field actually meet the real needs required to fulfill the operational mission of that OF? And: if they do not do so adequately, how can deficiencies be overcome?

We can state the hypothesis formally as follows:

> OFxx is staffed and Marines are trained in such a way that the current personnel structure and training are adequate to accomplish the mission of the OF.

Alternatively:

> The staffing and training of personnel in OFxx are not adequate to accomplish its mission.

When the problem is stated in such a fashion, it is far easier to plan and operationalize research in order to determine which of the two (or more) competing hypotheses is correct.

B. Contribution of Theory. A theory is a set of plausible propositions that appear to explain and predict certain phenomena. In the Marine Corps there exists a set of propositions which tends to do this as well. While not formally stated or recognized as a theory, it in fact governs some behaviors of some individuals under some circumstances. It is not an elegant theory, and it falls short of many demands placed upon other theories, but none-the-less, it exists and functions to some degree. We have chosen to call this the "CAN DO" THEORY. It has its roots in the indoctrination during recruit and officer training; it is formally recognized as being of social value to the Marine Corps; and, it is acted upon so frequently that we can expect it to be of value in solving part of the research problem stated above.

That is one of the criteria of a theory. It exists to help solve problems. If it were to be stated more formally, the CAN DO theory would probably go something like this:

1. The Marine Corps has a mission to fulfill.
2. The Marine Corps has traditionally fulfilled this mission under both optimal and sub-optimal circumstances.
3. OFxx is part of the Marine Corps and has its own support mission to fulfill.
4. OFxx will probably fulfill its mission.

From these statements one can begin to operationalize research on the problem based on the CAN DO theory. Stating this in the form of a hypothesis we have:

> If OFxx is to fulfill its mission, then it must have a personnel structure which permits it to do so.
> If it has the personnel structure to do so, then that structure exists because:
> a. It is properly staffed and trained, or
> b. It is improperly staffed and trained, but deficiencies in training and staffing are made up for informally, and the structure still exists and the mission is accomplished.

As indicated above, this is not the most elegant theory science has seen, but it probably is not the worst either. The fact is that often the proof of the pudding is in the eating, and if the theory serves to lighten the difficulties of the research process and bring about correct and efficient findings, then it stands on its own merit.

C. Operationalizing the Research. Once the problem has been specified, and a theoretical guidance or direction (Hypothesis) has been established, it is necessary to begin searching for ways in which the hypothesis can be tested. There are

several ways to do this and they are often used jointly.

1. Review of the Literature. In OMU's case, this involves searching through Tables of Organization and training Manuals, etc., in order to find exactly what the nature and mission of the Occupational Field is. It is at this point that someone familiar with the field can provide valuable clues and leads to the OMU investigation.

2. Observation and Interview. In order to supplement the review of literature, it is necessary to find out what it is that the incumbents in this field actually do. There are several ways for carrying out this assignment and many of them are discussed in reports prepared in Research Area 1 Observation and Interview and Research Area 2 Task Inventory Construction.[1] In addition, a source that should not be overlooked, and which should be quite reliable, is made up of local records. Such records as Work Order forms, personnel turn-over jackets and other local forms, e.g., man-hour reports, can all be used to improve the operationalization of the research.

3. Measurement Instruments. Once the basic background is obtained, the instruments for measurement can be designed. Again, other Research Areas in the Project have striven to provide guidelines on this, and it is referenced here to maintain the logical sequence of the research design.

Together, these steps can be called Operationalization. This is the process by which the broad concepts delineated in the Statement of the Problem and Theoretical Contribution

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1. See Technical Reports No. 2 and No. 11.

(Hypothesis) are reduced to measurable variables.

No hypothesis can be tested as valid or invalid until the concepts it articulates are operationalized and measured in the form of variables. Very often this is the real challenge in designing research. How, in fact, does one reduce a concept such as "current personnel structure" to a variable or group of measurable variables? What is "adequate". What, in fact, is a "task", and how does it differ from an "element" or a "job"? These are salient issues in the Operationalization stage of the research, and here is where most problems arise. It is at this point that an individual's personal background is likely to help or hinder. It is precisely at this stage in the process of research where it is most necessary to explicate the researcher's rationales for decisions. It is at this point that the greatest objectivity and creativity are necessary. And it is just at this point that there are no "cookbook" guides available for researchers, especially in Task Analysis.

In many other research endeavors there are standardized inventories, check-lists, tests, and questionnaires that have been checked for validity and reliability and are available to the researcher. However, since Task Analysis deals with a unique problem in the study of each Occupational Field, such "pre-cooked", standardized instruments are not available. As a consequence of all this, it is necessary to be most careful and most critical of the statements that are selected for inclusion in the inventory. The ideal method of resolving this

problem would be to conduct a PRE-TEST on a small proportion of the incumbents in an OF. Often, however, this is not feasible, and the final decision about what to include or exclude must be made subjectively.

At this point, behavioral scientists studying individuals in their natural environments rely heavily on KEY INFORMANTS. These are individuals whom the researcher has reason to believe have extensive knowledge of the subject area of the study. Behavioral scientists go to key informants and have them review their questionnaires and inventories. They ask them to delete items which are unclear or redundant, or to help re-word items to make them more understandable. It may be that OMU can obtain the expert opinion of several of these key informants who are in operational posts in order to have them assess the inventory statements. In any case, in terms of research design generally, this is one of the most critical issues of concern to any researcher. Do the questions truly measure the concept?

D. Determining Sample Size. Sample size is often determined in conjunction with the earlier stages of the design, and is placed in this position as a separate step because of its complexity. Research Area 3 has prepared guidelines for this portion of the research design, (See Technical Report No. 12) and it would be redundant to repeat them here. The crucial point to recognize is that often there may be non-statistical reasons for modifying a decision about sample size. This may be due to monetary or time concerns, availability of subjects, or many other factors. However, when a decision regarding the

size and type of a sample is made, the rationale for that decision should be spelled-out clearly, along with the strategy by which the sample is to be obtained. One of the most damaging attacks that can be made against otherwise well-conceived and operationalized research is to point out flaws in its sampling design or techniques. A large sample is not necessarily a good sample, and a small sample is not necessarily a bad one. What makes a sample good or bad is how well it meets the needs for answering the research questions. (See Technical Report No. 12.)

E. Collecting the Data. This is a relatively straightforward portion of the research process. However, an important requirement is that the individual who administers the inventory should avoid any actions which might create bias in the answers of respondents. Often such "minor" factors as tone of voice, facial expression, posture, yawning, impatience, etc., can completely ruin the collection of data. Even the choice of setting for administration can affect the results. Another concern which parallels this is uniformity of instructions. If, for example, questions are likely to arise about what is an "average amount of time," such definitions should be made clear to all administrators before any inventories are administered. Again, this means spelling-out exactly what the researcher means by such a phrase. And again, it involves much of the researcher's background and personality. It is clearly the case that "average" often means different things to different individuals. In order to assure that answers are

comparable, a common definition or standard must be specified, preferably in writing, and read aloud to respondents.

F. Analyzing the Data. A research program must always be designed with the type of data-analysis techniques to be used clearly in mind. As a result, the researcher must constantly make sure that his findings meet the requirements imposed by his analytical techniques. This is especially important when certain types of statisrical analysis are to be used. Data must be appropriate for these analytical procedures. In the case of OMU, there is a pre-existing analytical package of computer programs specifically designed for Task Analysis. This Comprehensive Occupational Data Analysis Program (CODAP) contains numerous sub-routines which provide summary information about task inventory data. It is essential that data analysts at OMU be completely familiar with the power and limitations of such routines so that they are neither under-used, nor stretched beyond their logical limits.

As has been stressed throughout these guidelines, it is of utmost importance to keep clearly in mind the purpose of the research (i.e., the statement of the problem). At each step in the analysis each team should ask, "Is this helping to answer the questions posed by the research problem?"

There are probably as many valid approaches to data analysis as there are researchers, even given the relative rigidity of the types of techniques used. As with the operationalization phase, the data analysis phase is a reflection of the characteristics of the researchers. All of their knowledge comes into

play at this point. Hunches and educated guesses often suggest clues to relationships which otherwise would have gone unnoticed.

However, along with such freedom, there are restrictions which must be observed. For each and every inference beyond the raw data, a rationale must be stated. It is clear that the further an analyst departs from the basic data the more tenuous the links of logic become. Because of this, it is necessary to define clearly each step to be taken by setting forth the assumptions implicit in the inferential process, the rationale that supports the inference, and the logical limitations which constrain the inference.

At the heart of data analysis in OMU is the heirarchical clustering program. The basic purpose of this routine is to find Marines who share certain similarities in tasks performed and group them together so that they form distinctive categories that are different from all other clusters and individuals in the sample.

Clustering or classification analysis is an activity performed by every individual throughout the course of his life. It is a necessary function of human activity that things be classified in some systematic way so as to include those that are alike and exclude other things. Take the simple example of food: What is food? What is non-food? If any human wants to survive, he must be able to distinguish foods from non-foods. Scientists in every field also are vitally concerned with making

similar distinctions. As a result of the complexity and variability of the objects which surround us, it has been necessary to find some mathematical way of clustering things so that the process is logical and objective. Subjective classifications tend to lack consistency and uniformity, and thus introduce errors because, as pointed out above, the researcher has numerous biases of which he is frequently not even aware. Recognition of this tendency has led to considerable study of the possible rationales and devices for objective clustering. (References on clustering and classification analysis are listed in the selected bibliography at the end of this report.)[1]

OMU has adopted some rule-of-thumb guidelines for determining objectively the critical inclusion level for stages or composites. The 35%, 50% homogeneity levels within and between stages is said to have been empirically derived as being the most efficient. However, it is often the case that such measures are not meaningful since the "true" cluster for a job type includes stages which fall short of these optimum figures. There is a sound mathematical reason for this. Principally, it is the result of a very large number of items in an inventory. As the number of items increases, the opportunity for an incumbent to respond to a large number of items is also increased. The greater the number of responses, the smaller the "time spent" and "shared time" spent percentages for any item become. Consequently, when the matrix is searched for the time similarity between and among incumbents, the probability is reduced that

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1. Also see Technical Report No. 1, HIERARCHICAL CLUSTERING: A BIBLIOGRAPHY.

any two or more individuals will manifest a high percentage of similarity. As a result, the principle of 35% and 50% may not hold, and lesser levels may be required for decisions on inclusion or exclusion.

Recognizing this, the researcher must examine all reasonable alternatives, and he should explicitly state why each and every decision was made at a particular stage. The consequences for ignoring the need for such a justification can be severe. For example, the results of an otherwise solid research design may be jeopardized. Assume that a decision was made to include a particular sub-group in some cluster, and no specific justification was stated. At later stages in the analysis, that group (which in reality belongs somewhere else) is not available for inclusion in its appropriate place because it has already been classified. This in turn affects the decisions made about other clusters of job types, resulting in a distorted analysis of the entire Occupational Field. Such cumulative errors require extensive trace-back time, and it is often impossible to identify successfully the location of the original error if justifications and rationales for each decision level are not specified. Too many personal variables enter into subjective decisions to be accurately recalled at a later time. For example, how often do many of us think back in time and say, "Now why would I do a thing like that? It makes no sense at all." If, on the other hand, justification for each decision is recorded, the analyst can

readily trace back the source of his error and rectify it.

Another problem which can plague cluster analysis is the issue raised by isolets, i.e., individuals who do not seem to fit in any of the clusters. There are two basic ways to view this phenomenon. One is the manner in which OMU is currently treating it. That is, isolets are considered as valid cases and are permitted to fall where they may in the clustering procedure. Often these fall out toward the "end" of the tree diagram, but they may be included elsewhere and distort the sub-group into which they are joined. On the other hand, they can be treated as deviates. In this case, they are assumed to be nonsense responses, i.e., attempts to deliberately mislead, or the result of misunderstanding some items, or, as highly specialized cases. Under this philosophy it is wise to extract the cases before clustering and decide if they are deviates or special cases.[2] In either instance, they are analyzed separately for the information they contain. If they are deemed special cases, then the appropriate analytical approach is to include them as CASE STUDY material in the research report. Case study is a powerful tool in analysis and should not be ignored.

In order to determine if there are such types of cases in the data before clustering, a simple procedure is recommended. Cross-tabulation provides a visual representation of responses by some criterion category. If the inventory, for example,

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2. For a more thorough discussion of this phenomenon, see Everitt, Brian, CLUSTER ANALYSIS, New York: Wiley, 1974, on "Outliers".

contains a number of tasks which usually fall in officer jobs, then it is a simple matter to sum the responses by these jobs and cross-tabulate them by rank. If one finds E-4's and E-5's answering a great number of tasks in the officer job categories, these cases can be examined for their worth before including them in the clustering routine. One OF examined showed an E-4 performing 21 officer-type tasks. This method of cross-tabulating certain variables is an excellent way of searching the data for unusual response patterns of any sort.[3]

Another problem in data analysis is when to stop. Often the data reveal numerous unforeseen relationships, and the conscientious researcher naturally desires to pursue the reasons for these. There comes a time, however, when this activity must be terminated and the write-up stage begun. This again requires the judgement of the researcher. The appropriate questions to ask are: "Have I answered the research question as completely as possible?" "Is there any further information which will improve the research report?" "How much will the further analysis add?" These are questions which can only be dealt with by the research team that has labored throughout the process. Cutting-off (or extending) an analysis requires a clearly stated rationale. Obviously no set of data is ever completely analyzed.

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3. CODAP does not have an adequate cross-tabulation routine. However, several are readily available from other standard sources. For example the IBM Statistical Sub-routine Package (SSP) can be readily used with this type of data.

There is always a stone left unturned or a parameter left uninvestigated. But the crucial issue lies at the heart of the research, the answer to a properly stated research problem. It is always possible to re-analyze data, but in many scientific activities it is important to find and report the results as quickly as possible. In the case of OMU, delay can result in a lag in management decision-making. In basic and applied science, a delay means postponing the dissemination of valuable information to colleagues who may be able to build their own research on the findings. However, time expediency is not a sufficient rationale for terminating data analysis. We must return to the basic issue: Does what we have satisfy the requirements of the research problem?

G. The Research Report. The product of all the blood and sweat, excitement and boredom of the reseach process is the research report. Of what does it consist and how is it organized?

Essentially, the research report puts flesh on the research design. Conventionally, the report re-states the problem, theory, operations, sampling and collection procedures, and the analytical process. However, it also specifies all the decision rationales which led to the conclusions and recommendations. In other words, the report should be a faithful record of the researchers' logic from the problem formation to the conclusions. It is the basis upon which the results and the researchers are judged. The more thorough and painstaking the report, the greater its

credibility and impact and the probability that its recommendations will be acted upon by recipient policy-makers.

This is the central issue of credibility. It is not that the findings be consistent with Marine Corps Manpower philosophy and doctrine that is crucial. Rather, it is the DEPTH and STRENGTH of the analysis and the rationale of findings that are critical. If each decision is justified by data; if the steps in analysis are specified; if solid rationale is presented for sampling strategies; if the operations clearly represent measures of the concepts; and, if the problem is well defined and stated, then the researcher can be reasonably sure that his product will receive acceptance and serious consideration. It is when these criteria are unmet or are violated that policy-makers justifiably ignore or criticize the product. One of the best ways to produce a credible report is to follow the steps outlined above.[4]

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4. For a discussion of guidelines for writing a report with clarity and with ease of understanding by the reader, see Technical Report No. 8, Communications in Task Analysis, Training Manual IV, Ch. 3, pp. 28-73, "How to Write Clearly".

BIBLIOGRAPHY

There are numerous excellent books and articles on the topic of analytical philosophy and research design. Listed below are a few which can be helpful to OMU personnel who wish to pursue this subject further.

Campbell, Donald and Sulian, Stanley, EXPERIMENTAL AND QUASI-EXPERIMENTAL DESIGNS FOR RESEARCH, Chicago: Rand McNally and Company, 1966.

Everitt, Brian, CLUSTER ANALYSIS, New York: Wiley, 1974, on "Outliers".

Festinger, Leon and Katz, Daniel, RESEARCH METHODS IN THE BEHAVIORAL SCIENCES, New York: The Dryden Press, 1953.

> The authors give special attention to Sampling, Field Studies, and problems of Data Analysis.

Hempel, Carl, PHILOSOPHY OF SCIENCE, Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1966

Jahoda, Marie, and Deutsch, Morton, and Cook, Stuart W., RESEARCH METHODS IN SOCIAL RELATIONS, New York: The Dryden Press, 1951.

> Detailed discussion of the research process, with chapters on formulation and statement of research problems, research design, measurement problems and techniques, observational methods, questionnaire construction, interviews, and theory in research. Definitely a "How To" text for behavioral research.

Kaplan, Abraham, THE CONDUCT OF INQUIRY, San Francisco: Chandler, 1964.

Nagel, Ernest, THE STRUCTURE OF SCIENCE, New York: Harcourt Brace, Inc., 1961.

Popper, Karl, THE LOGIC OF SCIENTIFIC DISCOVERY, New York: Basic Books, Inc., 1959.

Rudner, Richard S., THE PHILOSOPHY OF SOCIAL SCIENCE, Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1966.

Selltiz, Claire, et.al., RESEARCH METHODS IN SOCIAL RELATIONS, New York: Holt-Dryden, 1959.

Stephens, William N., HYPOTHESES AND EVIDENCE, New York: Thomas Crowell Company, 1968.

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